WHAT IS CLAIMED IS:

1. A molecular shuttle device comprising:

(a) two or more molecular subunits connected to form a molecular chain, the subunits defining binding positions along the molecular chain; and

(b) a shuttle capable of binding at each of the binding positions;

wherein the shuttle moves between binding positions in response to one or more input signals which interact with the molecular subunits.

2. The molecular shuttle device of claim 1, wherein the molecular chain and the shuttle are in solution.

3. The molecular shuttle device of claim 1, wherein interactions between the one or more input signals and the subunits break bonds between the shuttle and the subunits.

4. The molecular shuttle device of claim 1, wherein interactions between the one or more input signals and the subunits make bonds between the shuttle and the subunits.

5. The molecular shuttle device of claim 1, wherein the input signals for neighboring molecular subunits are resolvable.

6. The molecular shuttle device of claim 1, wherein the shuttle is capable of binding at the binding positions in the absence of an input signal.

7. The molecular shuttle device of claim 1, wherein the shuttle does not bind to the binding positions in the absence of an input signal.

8. The molecular shuttle device of claim 1, further comprising an antenna attached to each molecular subunit for receiving an input signal, wherein the

antennae for neighboring molecular subunits are adapted to receive resolvable input signals.

9. The molecular shuttle device of claim 8, wherein the antennae comprise molecules independently selected from the group consisting of nanoparticles, single-molecule magnets, and dye molecules.

10. The molecular shuttle device of claim 1, wherein the molecular subunits define only two binding positions.

11. The molecular shuttle device of claim 10, further comprising a fluorophore and a quencher for the fluorophore, wherein one of the fluorophore or the quencher is attached to the shuttle and the other of the fluorophore or the quencher is attached to a molecular subunit.

12. The molecular shuttle device of claim 1, wherein the molecular chain comprises three molecular subunits and further wherein the input signal for each of the three molecular subunits is resolvable with respect to the input signals of the other two molecular subunits.

13. The molecular shuttle device of claim 12, wherein the molecular chain comprises a repeating pattern of the three molecular subunits.

14. The molecular shuttle device of claim 1, wherein the shuttle is capable of binding to the molecular subunits individually.

15. The molecular shuttle device of claim 1, wherein the shuttle is capable of binding between adjacent pairs of molecular subunits.

16. The molecular shuttle device of claim 1, wherein the molecular subunits and the shuttle comprise oligonucleotide sequences.

17. The molecular shuttle device of claim 1, wherein the molecular subunits comprise molecules capable of forming zwitterions in response to an input signal and the shuttle comprises a charged molecule capable of undergoing ionic bonding to the zwitterions.

18. The molecular shuttle device of claim 1, wherein the molecular subunits comprise chemical moieties and the shuttle comprises functional groups capable of forming photocleavable covalent bonds with the chemical moieties of the subunits.

19. The molecular shuttle device of claim 1, wherein the input signals are independently selected from the group consisting of magnetic inputs and electric inputs.

20. The molecular shuttle device of claim 1, wherein the input signals comprise compounds that change the chemical environment of the device.

21. The molecular shuttle device of claim 1, wherein the molecular chain is attached to a solid support.

22. A molecular shuttle system comprising:

(a) two or more molecular subunits connected to form a molecular chain, the subunits defining binding positions along the molecular chain;

(b) a shuttle capable of binding at each of the binding positions; and

(c) an input signal sequence that interacts with the molecular chain, the input signal sequence comprising at least one input signal;

wherein the shuttle moves between binding positions in response to the input sequence.

23. The molecular shuttle system of claim 22, wherein the molecular subunits and the shuttle are in solution.

24. The molecular shuttle system of claim 22, wherein interactions between the input signal sequence and the subunits break bonds between the shuttle and the subunits.

25. The molecular shuttle system of claim 22, wherein interactions between the input signal sequence and the subunits make bonds between the shuttle and the subunits.

26. The molecular shuttle system of claim 22, wherein the input signals for neighboring molecular subunits are resolvable.

27. The molecular shuttle system of claim 22, further comprising an antenna attached to each molecular subunit for receiving an input signal, wherein the antenna for neighboring molecular subunits are adapted to receive resolvable input signals.

28. The molecular shuttle system of claim 22, wherein the molecular subunits define two binding positions on the molecular chain and further wherein the shuttle moves between the two binding positions in response to an input signal sequence, to provide a molecular switch.

29. The molecular shuttle system of claim 28, further comprising a fluorophore and a quencher, wherein one of the fluorophore or the quencher is attached to the shuttle and the other of the fluorophore or the quencher is attached to a molecular subunit, such that the fluorophore is quenched when the shuttle is in one of the two binding positions.

30. The molecular shuttle system of claim 22, wherein the molecular subunits define at least three binding positions on the molecular chain and

further wherein the shuttle moves between the at least three binding positions in response to an input signal sequence to provide a molecular assembly line.

31. The molecular shuttle system of claim 30, wherein the shuttle moves bi-directionally between the binding positions.

32. The molecular shuttle system of claim 23, wherein the molecular subunits comprise biomolecules, the shuttle comprises a biomolecule capable of hybridizing to the molecular subunit biomolecules, and the input signals interact with the molecular subunits to selectively dehybridize the shuttle from the molecular subunits.

33. The molecular shuttle system of claim 23, wherein the molecular subunits comprise biomolecules, the shuttle comprises a biomolecule capable of selectively binding to the molecular subunit biomolecules, and the input signals interact with the molecular subunits to selectively activate binding interactions between the shuttle and the molecular subunits.

34. The molecular shuttle system of claim 22, wherein the molecular subunits comprise biomolecules, the shuttle comprises a biomolecule capable of selectively binding to the molecular subunit biomolecules, and the input signals produce changes in the pH of the system to selectively activate binding interactions between the shuttle and the molecular subunits.

35. The molecular shuttle system of claim 22, wherein the molecular subunits comprise molecules capable of forming zwitterions, the shuttle comprises a charged molecule capable of undergoing ionic bonding to the zwitterions, and the input signals selectively convert the molecular subunit molecules from non-zwitterionic to zwitterionic forms.

36. The molecular shuttle system of claim 22, wherein the molecular subunits comprise molecules capable of undergoing a conformational

change from a first conformation to a second conformation, the shuttle comprises a molecule capable of binding to the molecular subunit molecules in either their first or their second conformation, and the input signals selectively convert the molecular subunit molecules from one conformation to the other.

37. The molecular shuttle system of claim 22, wherein the molecular subunits comprise chemical moieties, the shuttle comprises functional groups capable of covalently bonding with the chemical moieties of the subunit molecules, and the input signals photocleave the covalent bonds between the molecular subunit molecules and the shuttle.

38. A molecular assembly line for assembling a molecule, the assembly line comprising:

(a) two or more molecular subunits connected to form a molecular chain, the subunits defining binding positions along the molecular chain;

(b) a shuttle capable of binding at each of the binding positions;

(c) an assembly molecule attached to the shuttle; and

(d) one or more molecular building blocks disposed along the molecular chain;

wherein the shuttle moves between binding positions to bring the assembly molecule and building blocks into sufficiently close proximity to allow the building blocks to react with the assembly molecule, in response to one or more input signals which interact with the molecular subunits.

39. The molecular assembly line of claim 38, wherein the assembly molecule and the molecular building blocks comprise nucleotides.

40. The molecular assembly line of claim 38, wherein the shuttle comprises a bead.

41. The molecular assembly line of claim 38, wherein the molecular chain and the shuttle are in solution, such that the molecule is assembled in solution.

42. The molecular assembly line of claim 38, wherein the shuttle moves bi-directionally between the binding positions.

43. A molecular memory device comprising:

(a) a first bit comprising at least three connected molecular subunits, wherein each subunit is bound to a polymeric chain and further wherein the bond between the first subunit of the first bit and the polymeric chain may be broken by a first resolvable input signal, the bond between the second subunit of the first bit and the polymeric chain may be broken by a second resolvable input signal, and the bond between the third subunit of the first bit and the polymeric chain may be broken by a third resolvable input signal;

(b) a second bit comprising three connected molecular subunits, the second bit connected in a linear fashion to the first bit, wherein each subunit is bound to the polymeric chain and further wherein the bond between the first subunit of the second bit and the polymeric chain may be broken by the second resolvable input signal, the bond between the second subunit of the second bit and the polymeric chain may be broken by the first resolvable input signal, and the bond between the third subunit of the second bit and the polymeric chain may be broken by the third resolvable input signal;

(c) a readout moiety that moves along the substrate with a forward bias as each subunit becomes unbound from the polymeric chain; and

(d) a sequence of input signals that interact with the first and second bits, the sequence comprising input signals selected from the first resolvable input signal, the second resolvable input signal, and the third resolvable input signal.

44. The molecular memory device of claim 43, wherein the polymeric chain and the subunits comprises DNA molecules and the readout moiety comprises an enzyme.

45. A molecular shift register comprising:

(a) two or more connected bits, each bit comprising at least three binding positions defined by three or more connected molecular subunits, each binding position capable of binding a shuttle, wherein the shuttle moves from the first binding position of a bit to the second binding position of the bit in response to a first input signal, the shuttle moves from the second binding position of the bit to the third binding position of the bit in response to a second input signal, and the shuttle moves from the third binding position of the bit to the first binding position of a neighboring bit in response to a third input signal; and

(b) a sequence of input signals that interacts with the bits, the sequence comprising a repeating pattern of the first input signal, followed by the second input signal, followed by the third input signal.

46. A molecular shuttle device comprising:

(a) two or more molecular subunits connected to form a molecular chain, the subunits defining binding positions along the molecular chain; and

(b) a shuttle capable of translating along said chain by means of sequentially breaking and forming bonds between said subunits and said shuttle.

47. A molecular shuttle device comprising:

(a) two or more molecular subunits connected to form a molecular chain, the subunits defining binding positions along the molecular chain; and

(b) a shuttle comprising a translateable ligand capable of translating along said chain by means of sequentially breaking and forming bonds between said subunits and said shuttle.

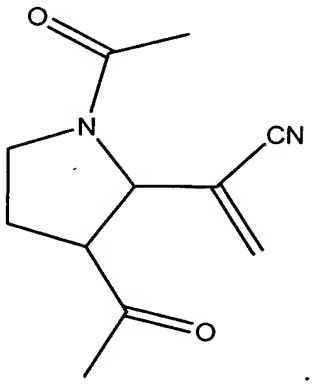
48. A molecular shuttle device comprising:

(a) two or more molecular subunits connected to form a molecular chain, the subunits defining binding positions along the molecular chain; and

(b) a shuttle capable of translating along said chain by means of sequentially breaking and forming bonds between said subunits and said shuttle in which

(c) said breaking or formation of said bonds is mediated by external input signals.

49. A compound having the structure:



50. A method for making the compound of claim 49, the method comprising the following scheme: